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Abstract

In this paper we examine the geographic patterns of employment growth and employment polarization in small and medium-sized cities (SMCs) in Denmark. The geography of employment polarization in Danish cities is examined using register-based employment data on occupations and wages divided into the public and private sectors in the period 1993-2006; the long period of transformation and growth in the Danish economy. We conclude that employment growth is characterized by employment polarization combined with growth in low- and high-wage employment and a decline in medium-wage employment. However, these patterns of polarization differ across the public and private sectors, as well as by geography. While local labour market (LLM) size, city position and city specialization influence the geography of private-sector employment growth and polarization, municipal population and composition influence the geography of public-sector growth patterns across wage levels. Finally, public and private employment are positively associated within SMCs, predominantly driven by the positive association between public employment and private-sector low-wage employment. However, public employment is not associated with an increase in private low-wage employment in more remote areas.

Keywords: Job polarization, Small and medium-sized cities, Local labour markets, Public sector

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Introduction

In recent decades, high- and low-skilled labour have increased, while the demand for medium-skilled labour has decreased in the private sector in Europe and North America (Goos et al., 2009). This employment growth pattern is mirrored in uneven wage growth across occupations. This change in labour and wage formation is referred to as job polarization (or employment polarization) in advanced economies (Goos and Manning 2007; Goos et al., 2009). The evidence suggests that the main drivers of employment polarization are skills-biased technological change and the global division of labour through offshoring (Goos et al., 2014).

In this paper we examine the geography of employment polarization in Danish cities, emphasising employment polarization in small and medium sized-cities (SMCs) to understand how it relates to the spatial aspects of industrial restructuring, the rise of the new economy, with its strong trends towards urbanisation and de-industrialisation, and peripheral job losses (Hansen and Winther, 2017). Despite recent studies in labour economics, and apart from a few contributions (Autor and Dorn 2013; Lindley and Machin 2014; Kaplanis, 2007; Jones and Green, 2009), relatively little is known about the geography of employment polarisation in SMCs or in local labour markets (LLMs) in Europe, although Bacalod et al., (2009), Florida et al. (2011) and Florida and Mellander (2016) examine metropolitan areas in the USA.

While urban and regional studies mainly focus on the impacts of agglomeration economies on urban regions (Scott, 2008; Glaeser, 2012; Storper, 2013), less attention has been paid to

employment developments in SMCs (Ward and Brown, 2009; Hansen, 2016; Erickcek and McKinny, 2006). The literature mainly shows a distinction between urban and rural regions (Hansen and Winther, 2017), with a strong urban bias towards central economic variables, including employment growth, wage levels and human capital. City-regions perform better than rural and peripheral regions. It is generally the case that urban size and position in the regional system influence employment trends in cities and LLMs. The new economy is concentrated in large city-regions, while rural and peripheral regions are dominated by agriculture, manufacturing and services (Irwin et al., 2010; Hansen and Winther, 2012). However, the industrial structure, including specialization and diversity within both the private and public sectors, as well as employment share and growth, are likely to affect changes in local private employment and polarization patterns.

In this paper, we conduct an empirical investigation into geographical variations in employment polarization patterns in both the private and public sectors to assess what may explain the new geography of employment, including main predictors such as LLM size, relative city size within LLMs and city-specific industrial structure, as well as municipal population and composition. We examine the geography of employment polarization in three ways. First, we assess employment polarization in different industrial sectors in Denmark to understand the overall change in the composition of jobs. Secondly, we investigate the distinct urban and regional geography of employment polarization. We are specifically looking at SMCs outside the five largest cities in Denmark, taking their respective positions in the urban and regional system and in LLMs into account. Finally, we evaluate the geographical association between changes in public and private employment respectively in order to understand the geography of employment polarization and to answer the following empirical questions:

- What kind of employment polarization has been produced in cities in the new economy in Denmark?
- Does city size and position in the urban and regional system have an impact on cities' polarization patterns?
- Does the public sector have a particular role in generating employment polarization patterns?

We thereby contribute to the literature by adding new knowledge about the geography of employment polarization during the rise of the new economy. We employ administrative employment register data containing annual employer-employee records for the entire Danish workforce with unique person and workplace identifiers for the years 1993-2006. We focus on this period, as it represents a long period of economic and employment growth, including the rise of the new knowledge economy and the intense urbanization of the largest city-regions in Denmark (Eriksson et al., 2017). We use robust regression to test the influence of location, size and the role of the public sector.

The paper is organized in the following way. First, we provide a short background to our key concepts and findings, followed by a section describing our empirical strategy in examining the spatial dimension of employment polarization in Danish cities, including the role of the public sector. The third section provides an overview of the data and variables. The fourth section analyses employment polarization in Danish SMCs. Finally, we provide some concluding remarks.

Background

Job or employment polarization refers to a situation in which there is growth in employment in both the high-skilled (professional and managerial) and low-skilled (personal services) occupations, but declining employment in the middle of the distribution of occupations (manufacturing and routine office jobs) (Goos and Manning, 2007; Goos et al., 2009), combined with growth in high-paid and low-paid jobs relative to middle-ranking jobs (Goos and Maning, 2003). This reflects the rise of the so-called 'new economy' in the west (Sassen, 1991; Scott, 2008; 2010), and as Autor et al. (2003) argue, one reason for this trend is that technology can replace labour in routine tasks, but not in the non-routine tasks found mainly in high-skilled and low-skilled occupations.

Empirical evidence for job polarization is available especially for the US and UK (Goos and Manning, 2003), but Goos and Manning (2009) also provide evidence for European countries, including Denmark, concluding that from the 1990s Europe too experienced job polarization, measured as a disproportionate increase in high-paid and low-paid employment. The spatial dimension of this trend has been relatively little studied so far, despite a focus in some work on global cities and metropolitan areas, as well as on human capital, income and wage differences (Sassen, 1991; Scott, 2010; Florida and Mellander, 2016). Regional studies mainly study relatively large regions (Kaplanis, 2007), the quality of jobs (Jones and Green, 2009) or US metropolitan areas (Bacolod et al., 2009).

The Geography of Employment Polarization

The contemporary urban and regional literature focuses specifically on city-regions and metropolitan areas as key sites of the new economy (Florida 2002; Scott 2008; Glaeser 2012; Storper 2013), including works published since the financial crisis of 2008 (Glaeser 2012; Hansen and Winther 2012; Moretti 2012; Storper 2013; Storper et al. 2015; Florida 2017). Relatively little attention has been paid to the economic dynamics of SMCs in intermediate, rural and peripheral regions. In a review of the literature on rural and small-town economies, Kilkenny (2010) concluded that only a few stories are told about sunset developments or de-industrialization, there being limited knowledge of spatial development in respect of job polarization in small and medium-sized cities and towns (Hansen and Winther, 2017; Erickcek and McKinny, 2006). Generally, it has been confirmed that city size has a positive impact on economic performance. Large cities and metropolitan areas perform better because they are the locations of agglomeration economies (Polense and Shearmur 2004; Glaeser and Berry 2005). Due to the hierarchy of agglomerations and externalities, the effects of proximity and of the relationship of smaller to larger cities within a region is important in understanding the development of cities and towns outside the larger city-regions. This indicates that the location of cities within regional systems has a significant impact on local processes of growth and decline. This further suggests that the transformation, development and potential of SMCs depend on their position not only in the urban hierarchy (their size), but also in regional systems in relation to changes in employment. Hence, cities and small towns are not independent units but must be understood in their broader regional contexts, including LLMs (Hansen and Winther, 2017).

Florida and Mellander (2016) have recently suggested that job polarization has an uneven geography, as the new economy concentrates in urban regions, especially the high-skilled jobs,

while the low-skilled jobs are more evenly distributed in space because they follow the distribution of the population. Sassen (1991) showed that the rise of global cities like London, New York or Tokyo as a result of global changes would lead to an increase in the polarization of the income and occupational distributions of workers as a result of the dynamics of the new economy creating mainly high- and low-paying jobs, combined with processes of de-industrialization leading to a loss of middle-earning jobs. This was emphasized by Jensen-Butler (1996), who argued that skill polarization in European cities would increase as a result of the transformation from fordist to post-fordist forms of economy (Eriksson et al., 2017).

Less studied, however, has been the regional dimension of employment polarization, although some studies have revealed differences marked by geography, education, gender and whether employment is part-time or full-time (Kaplanis, 2007; Lindley, 2010; Lindley and Machin, 2014: Salvatori, 2015). This geography is mainly examined with a focus on relatively large regions and provides evidence of regional differences in the UK. Kaplanis (2007) confirms the existence of employment polarization in the UK, which is attested for every region, with London standing out with the strongest trends. This is also evident in US metropolitan areas. Thus Lindley and Machin (2014) show how the increased concentration of more educated workers in particular spatial locations is important for labour market polarization, while Bacolod et al. (2009) found that the distribution of skills varies with the size of cities (metropolitan areas) in the US. This is supported by Florida et al. (2011), who observed that high-wage skills were concentrated in large metropolitan areas, low-wage skills in smaller ones. Jones and Green (2009) showed increased job polarization across most UK regions and marked regional differences in average job quality from 1997 to 2007 benefitting the already advantaged regions. Their analysis also suggests that the public sector has an important role in providing high-quality jobs outside London and the

South East. This indicates the importance of industrial sectors and the regional industry mix in determining the geography of employment polarization.

The Role of Industrial Sectors

Among the existing empirical contributions, it is common to rank occupations across all sectors using wages (Goos and and Manning, 2014). However, wages are not only correlated with skills but also with productivity, which varies between industries. As a result, developments in industrial employment can have an impact on employment polarization and hence on it geography because of the spatial division of labour in the new economy, with its strongly urbanized and de-industrializing economies (Hansen and Winther, 2017). The new economy is concentrated in large city-regions, while rural and peripheral regions are dominated by agriculture, manufacturing and services (Irwin et al, 2010; Hansen and Winther, 2012). Thus, the industrial structure is likely to have an impact on changes in local employment in cities, as well as on polarization patterns.

Moreover, it is equally important to understand the role of the public sector in examining the economic dynamics and geographical patterns of employment change and polarization (Hansen and Winther, 2014). The public sector in Denmark accounts for approximately 30% of national employment, and public expenditure amounted to more than 50% of GDP in 2006 (Danmarks Statistik, 2006). The Danish welfare state has a marked impact on both the national economy and local and regional economies through the three main layers of government, namely the state, the region and the municipality (Hansen and Jensen-Butler, 1996). Moreover, the spatial distribution of welfare-state jobs does not necessarily follow the logic of capitalist markets: most public services are non-tradable, and their location depends on the location of the population they serve

and on general demographic structures. Faggio and Overman (2013) examine the impact of public-sector employment on local labour markets in the UK and find that it has no identifiable impact on total private-sector employment but does have a crowding-out effect, while Jofre-Monseny et al. (2016) find minor impacts of public-sector employment in Spanish city areas. Thus, to understand the geography of employment polarization in Denmark and its spatial dimension in cities, the role of the public sector needs to be addressed (Hansen and Winther, 2014).

Empirical Strategy

To answer questions regarding employment polarization in SMCs in Denmark, we map the employment growth pattern across sectors and skills (see below) according to the commuting distance from each city to the nearest of Denmark's five largest municipalities in terms of employment and population, namely Copenhagen, Aarhus, Odense, Aalborg and Esbjerg. We control for the initial city, municipal and LLM characteristics, including population size and composition in the municipality and total private employment in the LLM in which the city is located, the LLM position of the city according to private-sector employment, and the level of specialization within the private sector in the city. The empirical regression used to estimate the relationship between changes in city employment and geography as the distance from city *c* to the nearest of five major cities in Denmark is:

$$\Delta N_c = \alpha + \boldsymbol{dist}'\boldsymbol{\beta} + \varepsilon_c \qquad (1)$$

where $\Delta N_{c,t}$ is the change in the log number of jobs within sectors and the sectoral skill levels in city c from 1993 to 2006, and $dist$ is a set of indicator variables identifying the average

commuting distance from city *c* to the nearest of five major cities in Denmark at intervals of 20-40 km., 40-55 km., 55-75 km. and 75+ km.

With regard to the geography of the private-sector employment growth pattern across SMCs, we further control for the initial private employment share of city c within the LLM, city-specific industrial specialization and LLM size, i.e. $X_c$and Z_L through:

$$\Delta N_c = \alpha + \boldsymbol{dist}_c'\boldsymbol{\beta} + \boldsymbol{x}_c'\boldsymbol{\gamma} + \boldsymbol{z}_L'\boldsymbol{\rho} + \varepsilon_c \quad (2)$$

Similarly, with regard to the geography of the public-sector employment growth pattern across SMCs, we control for municipal population size and composition, i.e. Z_M, employing:

$$\Delta N_c = \alpha + \boldsymbol{dist}_c'\boldsymbol{\beta} + \boldsymbol{z}_M'\boldsymbol{\delta} + \varepsilon_c \quad (3)$$

In the second part of the analysis, we investigate the association between the change in the log number of public- and private-sector jobs. First, we map geographical differences in the association between changes in public- and private-sector employment respectively across the distance to the nearest of the five largest cities using the following empirical regression:

$$\Delta N_c = \alpha + \theta\Delta N_{public,c} + \boldsymbol{dist}_c'\boldsymbol{\beta} + \boldsymbol{\vartheta}\boldsymbol{dist}_c'\Delta N_{public,c} + \varepsilon_c \quad (4)$$

where ΔN_c is the change in the log number of the total of private-sector jobs within three skills levels in city c from 1993 to 2006, and $\Delta N_{p,c}$ is the change in the log number of public-sector jobs in the same period.

Secondly, we control for the overall correlation between the initial population and labour market characteristics of city c, municipality *M* and LLM *L* in which city *c* is located, and hence identify

the additional private-sector employment growth associated with public-sector employment when private sector growth factors are held constant:

$$\Delta N_c = \alpha + \theta \Delta N_{public,c} + \boldsymbol{x}_c' \boldsymbol{\gamma} + \boldsymbol{z}_{\boldsymbol{M}}' \boldsymbol{\delta} + \boldsymbol{z}_{\boldsymbol{L}}' \boldsymbol{\rho} + \varepsilon_c \quad (5)$$

We use robust regression to estimate the parameters in equations (1) to (5), as the procedure is less sensitive to extreme values than the OLS regression procedure (Berk, 1990; Andersen, 2006) and provides the same straightforward interpretation as the OLS regression.

We test for spatial autocorrelation in the error term for each of the specified models using Moran's I test. The employed spatial weight matrix, $\boldsymbol{W_c}$, is the inverse distance matrix of city *c*, based on the average commuting distance travelled by commuters between municipalities, calculated in relation to commuting patterns in 2004-2006. Hence, the weight takes the value 0 if no one is commuting between the municipalities. Based on the Moran's I test, we find no reason to reject that the errors of the specified models are i.i.d.

Data

We use administrative employment-register data from Statistics Denmark containing annual employer-employee records for the entire Danish workforce with unique person and workplace identifiers for the period 1993 to 2006. We combine the employee records with yearly information on real hourly wages and occupational codes (ISCO-codes) drawn from the income-tax registers, as well as formal education using ISCED codes drawn from the central administrative person register. Furthermore, we link workplace records to information on the main economic activities in the workplace (NACE rev. 1 nomenclature codes; see Eurostat

(2006) for an overview), as well as workplace addresses to locate workplaces situated within city limits. For the purposes of this paper, we aggregate the data at the city level; see below.

Cities and local labour markets

For present purposes, cities are defined as geographically limited spaces consisting of a group of coherent buildings encompassing areas with buildings separated by fewer than 200 meters unless interspersed with public facilities, parks, cemeteries etc. Furthermore, city areas are time-consistent geographical areas with limits defined in 2012. Employing time-consistent city areas, we allow for the potential expansion or contraction in the building stock at the city boundaries within the reference period.

Figure 1. Map of selected cities, municipalities and local labour markets, 2006.

Local labour markets (LLM) include geographical regions in which the majority of the local population seek employment and the majority of local employers recruit labour (Goodman, 1970). Local labour markets are defined as those providing employment within municipality boundaries (from before the structural reform in 2007) and commuting patterns from 2005 following the algorithm employed in the general literature (Coombes and Bond, 2007; Casado-Díazet al., 2010; Halás et al. 2015). The analysis includes 36 mutually exclusive LLMs throughout the period. Whereas the definition and mapping of cities are provided by Kort og Matrikelstyrelsen, the definition and mapping of LLMs are provided by Statistics Denmark; see Figure 1.

Sample selection

We exclude self-employment, assistant spouses and employers, as well as subsidiary occupations, military service and employment in farming and fisheries. We also restrict employment to include all employees aged 16-64 years to ensure that the change in employment reflects the change in employment for individuals who are economically active.

Finally, we exclude cities with less than a yearly average of 200 employees in the private sector and 50 employees in the public sector in the period from 1993 to 1995. The final sample includes about 77% of total private-sector employment and 74% of total public-sector employment outside the five major cities. Between 11 and 15% of total employment outside the major cities is located outside cities defined by Kort og Matrikelstyrelsen, and about 9% of jobs are located in cities with fewer than 200 private-sector and/or 50 public-sector employees; see Table 1.

Table 1. Sample selection, location of jobs outside the major cities in percentages

Dependent variables

First, we define public- and private-sector employment according to the judicial status of the workplace. Hence, public-sector workplaces are controlled by the state, regional and municipal authorities. Further, within industries that predominantly belong to the public sector in Denmark, including administration, health care, primary and secondary education, higher education and social institutions, we treat self-governing institutions, as well as institutions controlled by funds

and the national church, as public-sector workplaces. In contrast, we characterize self-governing institutions and funds that own a large share of the housing sector as private-sector institutions.

In addition, we employ the NACE nomenclature code to differentiate between manufacturing industries that follow the Organization for Economic Co-operation and Development's (OECD) classification of technological intensity based on the ratio of R&D expenditure to the output value of individual industries. Hence, we categorize manufacturing workplaces into two categories: high- and medium- to hightechnology manufacturing industries and low- and medium- to low-technology manufacturing industries (Hansen and Winther, 2014). Similarly, we differentiate between two service sectors: traditional services and knowledge-intensive services, based on the ratio of labour with higher education. We further divide traditional services into two categories, business and private services. Finally, industries include activities in the categories of administration, health care, higher education institutions, primary and secondary schools and social institutions.

Finally, a category of other private industries and other public fields encompassing private (public) jobs within industries mainly performed by the public (private) sector was created. About 25% and 12% of employment in the health-care and higher educational system respectively are private-sector jobs. In contrast, between 2 and 5% of employment within social institutions, primary and secondary education and the administration are private jobs. Conversely, about 8% of knowledge-intensive employment consists of public-sector jobs.

Secondly, we employ two indicators of skills formation, namely occupational rank and the educational level of employees. In total, the data encompass [446] detailed occupations, including all Danish non-agricultural employment within the private and public sectors. In line with recent literature on job polarization (Autor and Dorn 2013), we rank occupations by skills

level, approximated by the mean log hourly wage of each occupation in the period from 1993 to 2006. Hence, we capture both occupations that disappeared and the creation of new occupations throughout this period. As the occupations are subsequently categorized into three major ranked groups, the minor changes in the mean log hourly wage rank of occupations across the period do not influence the results.

Hence, low-wage jobs include occupations with the lowest hourly wage held by 20% of employees within the public or private sector at the beginning of the period (i.e. 1993-1995). High-wage jobs encompass the average highest paid occupations held by 20% of employees within the public or private sectors at the beginning of the same period (i.e. 1993-1995). Finally, we employ educational attainment as an indicator of skills, categorizing employees according to their educational level into four categories: compulsory education, vocational education, short higher education and university education. Because of a general increase in the educational levels of the population, employing education as an indicator of skills formation may overstate the shift in the demand for skills in the short run. Hence, employees may be overqualified for their jobs, as the supply of highly skilled labour may exceed its demand.

Explanatory variables

We employ data on commuting patterns between municipalities in the period from 2004 to 2006 as the basis for calculating the average commuting distance between municipalities and the cities within them. Hence, we identify the shortest average commuting distance from each municipality and the five municipalities of Copenhagen, Aarhus, Odense, Aalborg and Esbjerg.

The first map in Figure 2 depicts municipalities according to the nearest of the five municipalities and the cities within them. The second map in Figure 2 depicts municipalities categorized according to the average distance to the nearest of the five largest municipalities.

Figure 2. Municipalities categorized according to the nearest of the five municipalities, together with the average commuting distance to the nearest of the five largest municipalities.

Finally, we include a range of control variables, as follows: 1) the natural logarithm to population size; 2) the share of children and young adults aged 0-17; 3) the share of elderly aged 65 and above of the municipal population in which city *c* is located; 4) the natural logarithm to the absolute number of employment in the LLM in which city *c* is located; 5) the position of city *c* within the LLM according to the size of employment; and 6) private-sector specialization ($CLQ_{i,c}$) in city *c*, i.e. the ratio between private employment in industry *i* in city *c* and total private employment in city *c*.

Table 2. Descriptive statistics at the city level categorized according to the distance to the nearest of the five largest municipalities in Denmark.

Table 2 gives the descriptive statistics of the variables. In the period from 1993 to 2006, Denmark experienced a transformation towards a service and knowledge economy (Hansen and Winther, 2012), which had a specific economic geography. First, private-sector employment growth is on average positive in cities in all distance categories, but gradually declines with distance to the five largest municipalities (the urban centres). Second, an employment

polarization pattern is evident in cities in all categories, characterized by an increase in low- and high-wage employment and a decline in medium-wage employment. The cities located more than 55 km from the five largest cities have relatively lower increases in low-wage employment and a stronger decline in medium-wage employment. Third, on average public-sector employment growth has been positive in cities closest to the five largest cities and negative in the two distance categories furthest away. Fourth, the employment polarization pattern is different from that in the private sector, showing a decline in low-wage employment and an increase in medium-wage and high-wage employment in cities closest to the centres. The decline in low-wage employment increases with distance from the urban centres, and in the cities more than 55 km from the centres a decline in high-wage employment can be observed.

Moreover, the control variables also reveal a distinct geography of SMCs. First, LLMs are generally larger close to the urban centres. In terms of industrial sectors, low-tech manufacturing becomes more important with distance, while high-tech manufacturing is more equally distributed, as are business services and private services, while knowledge services are concentrated close to those centres. In terms of population, there is an almost equal distribution of 0-17 and 65+ age ranges and of the size of municipalities.

Results

Table 3 reveals that Denmark saw overall employment polarization between 1993 and 2006, with an increase in low-wage and high-wage occupations and a decline in medium-wage occupations in the private sector. This confirms other findings (Manning et al., 2009). However, this general pattern covers different sectoral developments. In manufacturing, there has been a marked decline in both low-wage and medium-wage employment and an increase in high-wage

employment, the latter being driven by high-tech manufacturing. Knowledge services have a classic job polarization pattern, with an increase in low- and high-wage employment and a decline in medium-wage employment. In business services and private services, there is relative job polarization, as low-wage and high-wage employment have higher growth rates than medium-wage employment. The public sector is different and shows an increase in high-wage employment but a decline in both low- and medium-wage employment. This pattern, however, varies strongly among sectors, with social institutions being the only sector with an increase in low-wage employment.

Table 3. Employment growth patterns in the private and public sectors, 1993-2006, in percentages.

The geography of private and public employment growth

Tables 4 and 5 depict the results of the geographical mapping of the employment growth patterns in the private and public sectors respectively. The conclusion drawn from Tables 4 and 5 is that it is size, not distance, that matter for employment growth, confirming recent findings (Hansen and Winther, 2017). However, the employment growth patterns are correlated with the distance to the major cities. Hence, we find that, whereas the private-sector employment growth rate in SMCs located within 40 km of the larger cities is on average about 13 percent, the employment growth rate in SMCs in more remote areas is 6 percent.

Public-sector employment growth rates within SMCs differ even more with distance to the major cities. Whereas the growth rate is 8 percent in SMCs within 55 km of the larger cities, public-

sector employment has been stable or has declined by 5 percent in SMCs located more than 55 km away. The geographical differences in respect of both private and public growth rates are statistically significant.

However, when controlling for the initial LLM size and city position within LLMs, we find no association between the distance to the nearest of the five largest cities and the general private-sector employment growth rate. In contrast, a 10 percent higher initial LLM size is associated with 0.2 percent higher growth in private-sector employment. Further, average private employment growth is about 7 to 10 percentage points lower in the 4th largest or smaller SMCs than the larger SMCs within the same LLM. As we do not find a correlation between the different measures of industrial shares and overall private-sector employment growth, we leave out the results including the industrial shares here.

Similarly, we find no association between distance to the five largest municipalities and the change in overall public-sector employment when controlling for municipal population size and the share of the population aged 17 or below and 65 or above in the period from 1993 to 1995. In contrast, we find that a 10 percentage point higher share of elderly aged 65 and above in the municipal population is associated with 0.1 percent lower employment growth in the public sector. This may in part reflect the correlation between a decline in the municipal population in the period from 1993 to 2006 and the decline in public employment, as a larger share of elderly in the population is highly correlated with population decline.

The geography of private and public employment polarization

The geography of overall growth in private-sector employment, however, does not reflect the geography of the polarization of employment. Whereas the decline in medium-wage employment and the growth in high-wage employment generally apply across the distances to the major cities, the growth in low-wage employment is unevenly distributed by geography. Hence, geographical differences in low-wage employment growth drive the geographical differences in overall private employment growth. However, as in the case of overall private employment growth, LLM size and city position at the beginning of the period explain the geographical differences in low-wage employment growth. A 10 percent increase in the initial LLM size is associated with a 0.4 percent increase in low-wage employment growth, average low wage employment growth being about 12 to 15 percent lower in the 2nd largest SMC or smaller SMCs than in the largest SMCs within the same LLM. In contrast to the general employment pattern, we find that higher shares of low- and high-tech manufacturing employment within the city are associated with a significantly lower growth rate in low-wage employment in the private sector. The geography of the growth patterns of low-, medium- and high-wage employment is reflected in a similar geographical growth pattern across educational groups.

In contrast, general public-sector employment growth is largely reflected in the geography of the employment growth pattern across wage levels. Whereas low-wage employment is stable in SMCs within 20 km of the larger cities, it declined by between 15 and 28 percent in SMCs located more than 20 km from the major cities. We find the greatest decline in SMCs located in the most remote areas. Similarly, while medium- and high-wage employment has increased by about 7 and 9 percent respectively in SMCs within 20 km of the major cities, they have been stable or declined by about 5 percent in the SMCs located in the most remote areas.

Table 4. Robust regression results of overall employment growth and polarization in the private sector, 1993-2006. Coefficients and (Std. Er.).

However, while the correlation between distance and low-wage public employment is explained by the shares of both young and old in the population, high-wage public employment growth is explained by population size, as a 10 percent higher initial municipal population size is associated with a 1.2 percent higher high-wage employment growth. In contrast, the association between distance and medium-wage public employment growth strengthens when controlling for municipal population size and the share of the population aged 65 or above. We find similar patterns for the three educational groups within the public sector. However, here the lower employment growth of both the lowest and highest educational groups in remote areas is substantially explained for by the share of the municipal population aged 65 or above.

Table 5. Robust regression results of overall employment growth and polarization in the public sector at the city level, 1993-2006. Coefficients and (Std. Er.).

The geographical association between changes in public and private employment

Finally, we investigate the geographical association between changes in public employment and private-sector employment growth and polarization. In Table 6, we present the results from the robust regression of private-sector employment growth, including for total, low-, medium- and high-wage employment on changes to public-sector employment. In the A columns, we examine the additional private employment growth associated with changes to public-sector employment within SMCs when controlling for private-sector employment growth factors, including LLM

size, city position and shares of industrial employment. In the B columns, we investigate whether the association between public- and private-sector employment growth differs with distance to the major cities.

As depicted in column one in Table 6, we find that a 10 percent increase in public-sector employment is associated with a 0.7 percent additional increase in total private employment growth when controlling for its main determinants. Hence, higher growth or weaker decline in public employment is associated with additional private-sector employment growth. The correlation is, however, borderline statistically significant.

Table 6. Robust regression results of the geographical association between public and private employment change and polarization at the city level, 1993-2006. Coefficients and (Std. Er.)

Further, as depicted in the second column in Table 6, we find that the overall correlation between public and private employment growth generally applies across the distance to major cities.

However, it is the private low-wage employment growth in SMCs that drives the positive association between changes in public employment and total private employment growth. Whereas a 10 percent increase in public-sector employment is associated with a 1.1 percent additional increase in private low-wage employment within SMCs, the correlation between changes to public employment and private medium- or high-wage employment growth is statistically insignificant. Further, in contrast to the association between total public and private employment, we find that that between public employment and low-wage employment differs with distance to the major cities. Hence, whereas a 10 percent increase in changes to public

employment is associated with a 4.1 percent increase in low-wage employment growth in SMCs within 20 km of the larger cities, additional public employment growth is not associated with higher private low-wage employment growth in SMCs further away from the major cities. Based on the clear concentration of private low-wage employment growth in the larger SMCs within LLMs (cf. Table 4), this result may be due to a more homogenous growth or decline in public employment across SMCs within the defined distance zones.

Conclusion

This paper has examined the geography of employment polarization in small and medium-sized cities in Denmark during the rise of the new economy to analyse what kinds of job polarization have been produced in cities and whether city size and position in the urban and regional system has had an impact on the cities' patterns of job polarization. Finally, we examined the particular role of the public sector in influencing employment polarization patterns.

First, we can conclude that in the present case employment growth is characterized by classic job polarization, with a growth in low- and high-wage employment and a decline in medium-wage employment. Secondly, job polarization patterns differ markedly across the public and private sectors and by geography. LLM size, city position and local city specialization influence the geography of private-sector employment growth and polarization. Likewise, municipal population and composition are significant factors in the geography of public-sector growth patterns across wage levels. Finally, public and private employment are positively associated within SMCs, being predominantly driven by the positive correlation between public employment and private-sector low-wage employment. However, public employment is not associated with an increase in private low-wage employment in more remote areas.

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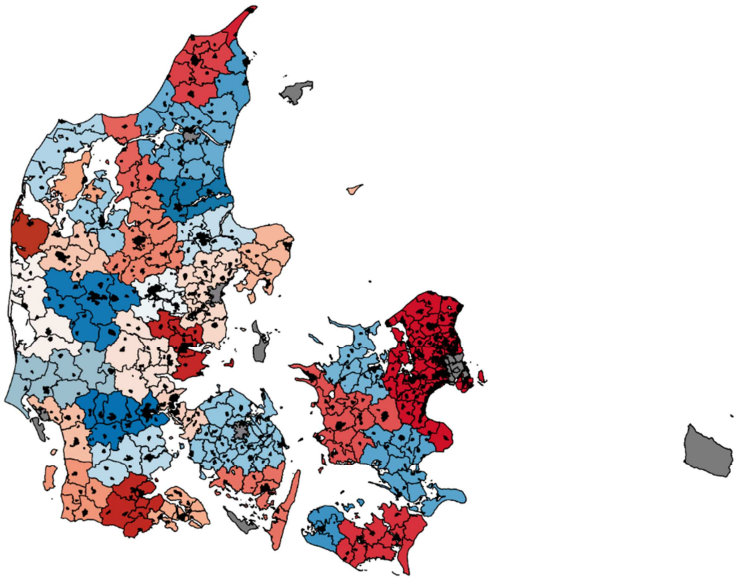
Figure 1. Map of selected cities, municipalities and local labour markets, 2006.



Note: The analysis encompasses 392 cities, 275 municipalities and 36 local labour markets.

Figure 2. Municipalities categorized according to the nearest of the five municipalities, together with the average commuting distance to the nearest of the five largest municipalities.

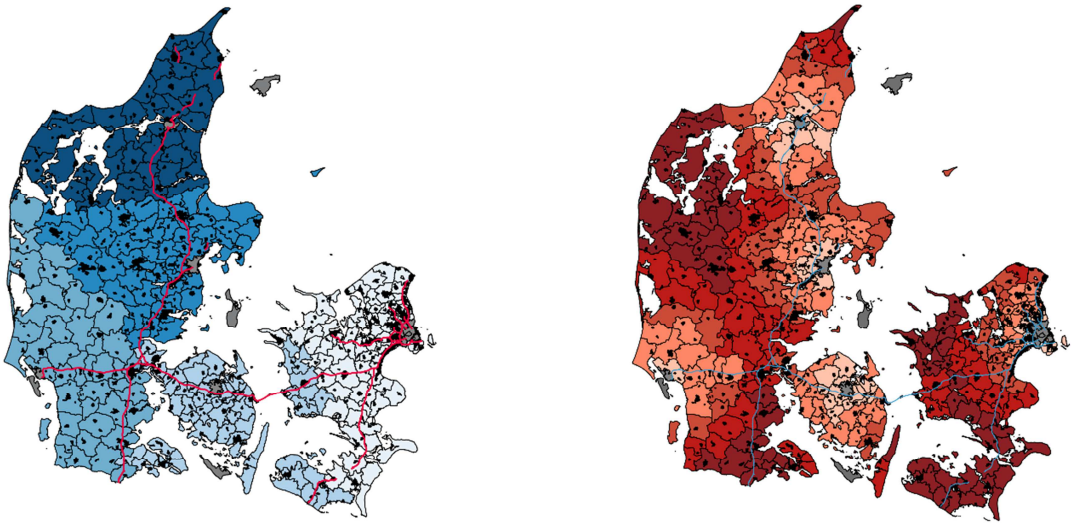


Table 1. Sample selection, location of jobs outside the major cities in percentages.

	Period	Not located	Located outside cities	Located in non-selected cities	Located in selected cities	ISCO code	ISCED code
Total	1993/95	1.3	12.8	9.2	76.7	94.2	98.5
	2004/06	1.6	13.7	9.2	75.5	89.9	98.6
Private	1993/95	1.2	11.3	9.2	78.3	92.8	98.4
	2004/06	1.6	13.1	8.9	76.4	87.2	98.4
Public	1993/95	1.5	15.7	9.1	73.6	97	98.8
	2004/06	1.5	15.1	9.8	73.6	96.1	99.2

Table 2. Descriptive statistics at the city level categorized according to the distance to the nearest of the five largest municipalities in Denmark.

	0-20 km		20-40 km.		40-55 km.		55-75 km.		over 75 km.	
Private sector employment	0.14	(0.22)	0.11	(0.17)	0.10	(0.22)	0.04	(0.27)	0.02	(0.27)
Low wage	0.19	(0.31)	0.13	(0.22)	0.12	(0.35)	0.02	(0.31)	0.04	(0.32)
Medium wage	-0.09	(0.23)	-0.06	(0.20)	-0.06	(0.25)	-0.13	(0.32)	-0.17	(0.35)
High wage	0.25	(0.42)	0.24	(0.26)	0.23	(0.30)	0.22	(0.37)	0.23	(0.31)
No education	0.02	(0.20)	-0.03	(0.21)	-0.02	(0.24)	-0.11	(0.28)	-0.12	(0.28)
Vocational	0.17	(0.24)	0.21	(0.15)	0.19	(0.22)	0.16	(0.27)	0.13	(0.28)
College or University	0.57	(0.62)	0.43	(0.59)	0.48	(0.57)	0.49	(0.60)	0.44	(0.42)
Public sector employment	0.08	(0.24)	0.06	(0.26)	0.04	(0.20)	-0.02	(0.20)	-0.05	(0.23)
Low wage	-0.02	(0.50)	-0.19	(0.59)	-0.27	(0.62)	-0.28	(0.41)	-0.38	(0.39)
Medium wage	0.07	(0.24)	0.09	(0.25)	0.07	(0.21)	0.02	(0.22)	-0.02	(0.28)
High wage	0.12	(0.52)	0.08	(0.50)	0.03	(0.34)	-0.06	(0.31)	-0.09	(0.31)
No education	-0.25	(0.35)	-0.29	(0.33)	-0.36	(0.31)	-0.41	(0.27)	-0.48	(0.29)
Vocational	0.20	(0.25)	0.20	(0.27)	0.19	(0.19)	0.14	(0.19)	0.12	(0.23)
College or University	0.52	(0.68)	0.37	(0.61)	0.34	(0.64)	0.28	(0.64)	0.20	(0.66)
LLM size	12.49	(1.02)	11.73	(1.30)	11.33	(1.64)	10.81	(0.95)	10.26	(0.70)
The largest city	0.00	(0.00)	0.01	(0.11)	0.14	(0.35)	0.11	(0.32)	0.21	(0.41)
2nd or 3rd largest city	0.09	(0.28)	0.17	(0.38)	0.22	(0.42)	0.23	(0.42)	0.27	(0.45)
4th to 6th largest city	0.09	(0.28)	0.23	(0.42)	0.19	(0.40)	0.25	(0.44)	0.28	(0.45)
7nd or 10rd largest city	0.14	(0.35)	0.17	(0.38)	0.12	(0.33)	0.18	(0.39)	0.18	(0.39)
11th or smaller city	0.69	(0.47)	0.41	(0.50)	0.33	(0.47)	0.23	(0.42)	0.06	(0.24)
CLQ: low tech	0.20	(0.17)	0.26	(0.19)	0.27	(0.15)	0.32	(0.18)	0.28	(0.17)
CLQ: high tech	0.12	(0.14)	0.10	(0.12)	0.13	(0.15)	0.09	(0.13)	0.13	(0.16)
CLQ: business services	0.15	(0.11)	0.12	(0.10)	0.10	(0.07)	0.12	(0.10)	0.12	(0.09)
CLQ: private services	0.22	(0.10)	0.26	(0.11)	0.26	(0.13)	0.24	(0.11)	0.25	(0.10)
CLQ: knowledge services	0.13	(0.14)	0.11	(0.07)	0.08	(0.04)	0.09	(0.05)	0.09	(0.05)
Municipal population	10.52	(1.36)	9.42	(0.62)	9.57	(0.71)	9.38	(0.65)	9.34	(0.63)
Population share aged 0-17	22.64	(3.08)	24.78	(1.72)	24.08	(1.62)	24.75	(1.76)	23.86	(2.43)
Population share aged 65+	14.23	(4.32)	14.55	(3.42)	15.06	(2.82)	14.93	(2.06)	16.75	(2.56)
Observations	73		91		71		81		76	

Table 3. Employment growth patterns in the private and public sectors, 1993-2006, in percentages.

	Total	Low wage	Medium wage	High wage
Private sector	17.99	18.0	-4.2	41.1
Mining, etc.	22.82	-14.0	12.0	31.0
Low-tech manufacturing	-20.33	-43.8	-23.7	0.8
High-tech manufacturing	-0.25	-26.7	-11.7	25.7
Business services	2.15	33.0	3.6	28.5
Personal services	2.58	30.6	2.9	47.7
Knowledge service	2.34	20.2	-10.9	55.6
Other private fields	7.57	165.2	63.6	276.3
Public sector	-2.16	-18.7	-2.8	13.7
Administration	-1.82	-73.6	-15.6	10.7
Health care	0.74	-35.2	9.7	34.9
Higher education	-1.3	-49.2	-15.3	-5.4
School system	0.05	-27.9	1.6	10.1
Social institutions	1.95	33.7	14.6	53.5
Other public fields	-6.25	-75.9	-49.9	-8.4

Table 4. Robust regression results of overall employment growth and polarization in the private sector, 1993-2006. Coefficients and (Std. Er.).

	Total empl.		Low wage empl.		Medium wage empl.		High wage empl.	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
20-40 km.	-0.02	-0.01	-0.06	-0.01	0.01	0.01	-0.01	-0.01
	(0.03)	(0.03)	(0.04)	(0.05)	(0.03)	(0.04)	(0.05)	(0.05)
40-55 km.	-0.06 *	-0.04	-0.08	-0.02	-0.02	-0.04	-0.07	-0.09
	(0.03)	(0.03)	(0.05)	(0.05)	(0.04)	(0.04)	(0.05)	(0.06)
55-75 km.	-0.06 +	-0.03	-0.15 ***	-0.08 '	0.00	0.00	-0.05	-0.05
	(0.03)	(0.03)	(0.04)	(0.05)	(0.04)	(0.04)	(0.05)	(0.06)
75+ km.	-0.07 *	-0.04	-0.10 *	-0.03	-0.01	-0.03	-0.01	-0.03
	(0.03)	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.06)
LLM size (ln)		0.03 *		0.04 *		0.01		0.04 *
		(0.01)		(0.02)		(0.01)		(0.02)
2nd-3rd largest city		-0.04		-0.11 +		-0.02		-0.05
		(0.04)		(0.06)		(0.05)		(0.07)
4th-6th largest city		-0.07 +		-0.10 +		-0.03		-0.16 *
		(0.04)		(0.06)		(0.05)		(0.07)
7th-10th largest city		-0.10 *		-0.14 *		-0.08		-0.15 *
		(0.04)		(0.06)		(0.05)		(0.07)
<11th largest city		-0.07		-0.15 *		-0.07		-0.23 **
		(0.05)		(0.07)		(0.06)		(0.08)
CLQ: Low-tech man.				-0.46 **		-0.14		0.14
				(0.16)		(0.14)		(0.19)
CLQ: High-tech. man.				-0.39 *		0.03		0.20
				(0.17)		(0.14)		(0.19)
CLQ: Business serv.				-0.14		-0.09		0.10
				(0.20)		(0.17)		(0.22)
CLQ: Personal serv.				-0.19		-0.05		0.31
				(0.23)		(0.19)		(0.25)
CLQ: Knowl. serv.				-0.32		-0.33 +		0.24
				(0.24)		(0.20)		(0.27)
Constant	0.13 ***	-0.13	0.19 ***	0.07	-0.08 **	-0.01	0.24 ***	-0.24
	(0.02)	(0.13)	(0.03)	(0.22)	(0.03)	(0.19)	(0.04)	(0.25)
Observations	392	392	392	392	392	392	392	392
R^2	0.02	0.06	0.03	0.11	0.00	0.03	0.01	0.06

Note: Sign. levels: + <0.10, * <0.05, ** <=0.01 & ***<0.001

Table 5. Robust regression results of overall employment growth and polarization in the public sector at the city level, 1993-2006. Coefficients and (Std. Er.).

	Total empl.		Low wage empl.		Medium wage empl.		High wage empl.	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
20-40 km.	-0.06 +	-0.04	-0.16 *	0.06	-0.01	-0.04	-0.09 +	0.02
	(0.03)	(0.04)	(0.08)	(0.07)	(0.03)	(0.04)	(0.05)	(0.05)
40-55 km.	-0.04	-0.01	-0.27 ***	-0.09	0.01	-0.01	-0.05	0.04
	(0.03)	(0.04)	(0.08)	(0.07)	(0.04)	(0.04)	(0.05)	(0.05)
55-75 km.	-0.08 *	-0.05	-0.23 **	0.01	-0.04	-0.07 +	-0.14 **	-0.03
	(0.03)	(0.04)	(0.08)	(0.08)	(0.04)	(0.04)	(0.05)	(0.05)
75+ km.	-0.13 ***	-0.09 *	-0.34 ***	-0.01	-0.08 *	-0.10 **	-0.13 *	0.01
	(0.03)	(0.04)	(0.08)	(0.08)	(0.04)	(0.04)	(0.05)	(0.06)
Munic. pop (ln)		0.00		0.03		-0.01		0.12 ***
		(0.02)		(0.03)		(0.02)		(0.02)
Share aged <18		-0.01		-0.06 ***		0.01		0.00
		(0.01)		(0.01)		(0.01)		(0.01)
Share aged >64		-0.01 **		-0.08 ***		0.00		-0.01 *
		(0.00)		(0.01)		(0.00)		(0.01)
Constant	0.08 **	0.39	-0.03	2.11 **	0.07 **	-0.07	0.09 *	-0.97 +
	(0.02)	(0.33)	(0.06)	(0.69)	(0.03)	(0.36)	(0.04)	(0.50)
Observations	392	392	392	392	392	392	392	392
R^2	0.04	0.07	0.05	0.24	0.02	0.03	0.03	0.13

Note: Sign. levels: + <0.10, * <0.05, ** <=0.01 & ***<0.001

Table 6. Robust regression results of the geographical association between public and private employment change and polarization at the city level, 1993-2006. Coefficients and (Std. Er.)

	Private-sector empl.		Low-wage empl.		Medium-wage empl.		High-wage empl.	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
$\Delta\ln(N_{public})$	0.14	0.08 *	0.41 **	0.11 *	0.08	0.01	0.03	0.07
	(0.10)	(0.04)	(0.14)	(0.05)	(0.11)	(0.05)	(0.15)	(0.06)
20-40 km.	-0.02		-0.03		0.01		-0.00	
	(0.03)		(0.05)		(0.04)		(0.05)	
40-55 km.	-0.06 +		-0.06		-0.02		-0.07	
	(0.03)		(0.05)		(0.04)		(0.05)	
55-75 km.	-0.05		-0.12 **		0.01		-0.05	
	(0.03)		(0.05)		(0.04)		(0.05)	
75+ km.	-0.06 +		-0.07		-0.01		-0.01	
	(0.03)		(0.05)		(0.04)		(0.05)	
$\Delta\ln(N_{public})$,20-40km	-0.09		-0.42 *		-0.01		-0.04	
	(0.12)		(0.17)		(0.14)		(0.19)	
$\Delta\ln(N_{public})$,40-55km	-0.05		-0.25		-0.24		-0.07	
	(0.14)		(0.19)		(0.15)		(0.22)	
$\Delta\ln(N_{public})$,55-75km	-0.25 +		-0.34 +		-0.13		-0.05	
	(0.13)		(0.19)		(0.15)		(0.21)	
$\Delta\ln(N_{public})$,75+ km	-0.12		-0.33 +		-0.16		0.15	
	(0.13)		(0.19)		(0.15)		(0.21)	
LLM size (ln)		0.02 +		0.03 +		0.02		0.07 ***
		(0.01)		(0.02)		(0.02)		(0.02)
2nd-3rd city		-0.03		-0.10 '		-0.02		-0.07
		(0.04)		(0.06)		(0.05)		(0.07)
4th-6th city		-0.06		-0.09 '		-0.03		-0.21 **
		(0.04)		(0.06)		(0.05)		(0.07)
7th-10th city		-0.08 +		-0.14 *		-0.09 '		-0.18 *
+		(0.04)		(0.06)		(0.05)		(0.07)
<11th city		-0.04		-0.12 +		-0.05		-0.25 **
		(0.05)		(0.07)		(0.06)		(0.08)
CLQ: Low tech. m.		-0.72 +		-1.76 **		-0.47		0.16
		(0.38)		(0.54)		(0.46)		(0.60)
CLQ: High tech. m.		-0.47		-1.66 **		-0.30		0.30
		(0.38)		(0.54)		(0.46)		(0.61)
CLQ: Business serv.		-0.51		-1.48 **		-0.42		0.12
		(0.38)		(0.55)		(0.46)		(0.61)
CLQ: Personal serv.		-0.40		-1.54 **		-0.33		0.46
		(0.41)		(0.59)		(0.50)		(0.66)
CLQ: Knowl. serv.		-0.51		-1.41 *		-0.54		0.50
		(0.41)		(0.59)		(0.50)		(0.65)
Munic. pop (ln)		0.05 **		0.01		0.06 **		0.07 **
		(0.01)		(0.02)		(0.02)		(0.02)

Share aged <18			0.03	***		0.01			0.03	***			0.06	***
			(0.01)			(0.01)			(0.01)				(0.01)	
Share aged >64			0.01			-0.01			0.01				0.02	*
			(0.00)			(0.01)			(0.01)				(0.01)	
Constant	0.12	***	-0.85		0.16	***	1.28	'	-0.08	**	-1.28	+	0.24	***	-3.07	***
	(0.02)		(0.58)		(0.03)		(0.83)		(0.03)		(0.70)		(0.04)		(0.92)	
Observations	392		392		392		392		392		392		392		392	
R^2	0.03		0.15		0.06		0.14		0.01		0.06		0.01		0.11	

Note: Sign. levels: + <0.10, * <0.05, ** <=0.01 & ***<0.001